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# A Zigbee-Based Wildlife Intelligent Monitoring System

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**ABSTRACT:** Due to the urgent need for wildlife conservation and monitoring, we design Zigbee based intelligent wildlife monitoring system. Specifically, we leverage Zigbee based wireless communication technology, in conjunction with embedded devices and cameras, to achieve remote, real-time, and efficient image collection of wildlife habitats. The core components of the system include a data acquisition module, such as temperature, humidity, GPS, and image information, and a data transmission and processing module. The data acquisition module utilizes low-power sensors and camera equipment to ensure a stable collection of information on wildlife activity environments in various wilderness environments. Besides, the system integrates the Zigbee module, which transmits the collected environmental data information to the cloud server in real time and at high speed.NMonitor offers user-friendly accessibility, allowing users to remotely monitor and manage the system through web interfaces.

# I. INTRODUCTION

The health and migration patterns of wildlife are critical indicators of ecosystem health and biodiversity. Monitoring these patterns provides valuable insights into the effects of environmental changes, human activities, and climate change on wildlife populations. Understanding the health status and movement behaviors of animals is essential for the development of effective conservation strategies and management practices. For instance, tracking migration routes can reveal critical habitats that require protection[1], while health monitoring can detect early signs of disease outbreaks or stress factors affecting wildlife. This information is vital for maintaining ecological balance, ensuring the survival of species, and supporting the overall integrity of ecosystems. The decline in wildlife populations, driven by habitat loss, poaching, and environmental pollution, underscores the urgent need for innovative and efficient monitoring systems. The Internet of Things (IoT) represents a significant advancement in the field of environmental monitoring, offering sophisticated tools for tracking and analyzing wildlife. IoT technology involves interconnected devices equipped with sensors that collect and transmit data over the internet. In the context of wildlife tracking, IoT can integrate GPS devices, health monitoring sensors, and environmental sensors to gather comprehensive data on animal behavior, physiology, and interactions with their habitat[2]. GPS devices can provide real- time location data, enabling researchers to map migration routes and identify critical areas for conservation. Health monitoring sensors can track vital signs, such as heart rate and body temperature, offering insights into the health and well-being of animals. Environmental sensors can measure factors like temperature, humidity, and pollution levels, helping to understand the environmental conditions that impact wildlife[3]. The integration of these technologies enables the continuous collection of highresolution data, facilitating detailed analysis and timely interventions. IoT systems can operate autonomously, reducing the need for invasive monitoring techniques and minimizing human-wildlife interactions. The sensing layer includes various sensors (GPS, health, and environmental) attached to the wildlife to collect data[4]. The network layer utilizes low-power wide-area networks (LPWANs) such as LoRaWAN and NB-IoT for data transmission to gateways. The application layer involves cloud- based platforms for data storage, processing, and analysis. Arrows between layers illustrate the data flow from sensors to the cloud, enabling real-time monitoring and analysis of wildlife health and movements[5]. The primary objective of this study is to develop and implement an innovative IoT-based monitoring system designed to track the health and migration patterns of wildlife, thereby enhancing conservation efforts. Specifically, the study aims to create a comprehensive IoT system that integrates various sensors to provide real-time data on wildlife health metrics and movement behaviors. By deploying this system in a selected study area and focusing on specific wildlife species, the research seeks to gather detailed and continuous data that can be analyzed to identify significant patterns and trends. Through this analysis, the study aims to evaluate the effectiveness of IoT technology in improving the accuracy and efficiency of wildlife monitoring compared to traditional methods. Additionally, the research intends to explore the challenges and limitations associated with deploying IoT systems in natural habitats[6], providing insights into the practical considerations of such technologies in conservation efforts. The ultimate goal is to





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use the findings from this study to inform and support the development of more effective conservation policies and strategies, ensuring the long-term preservation of biodiversity. To achieve these objectives, the study addresses key research questions: How can IoT technology be effectively integrated into wildlife monitoring systems? What are the critical health metrics and migration pattern.

# BLOCK DIAGRAM



## **II. MODULES**

#### **POWER SUPPLY**

The power supply section is the section which provide +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.

The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

TRANSFORMER	•	RECTIFIER	•	FILTER	•	IC REGULATOR	•	LOAD	
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Block Diagram Of Power Supply

#### Transformer

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

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Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The transformer will step down the power supply voltage (0-230V) to (0- 6V) level. Then the secondary of the potential transformer will be connected to the bridge rectifier, which is constructed with the help of PN junction diodes. The advantages of using bridge rectifier are it will give peak voltage output as DC.

#### Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full- wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying Dc

### **Bridge Rectifier**

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.



Bridge Rectifier

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

- i. The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost.
- ii. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.
- iii. The result is still a pulsating direct current but with double the frequency.

T



Output Waveform Of DC





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#### Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

### Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts totens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.



Circuit Diagram Of Power Supply

#### BUZZER

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows.

It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board.

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Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic- based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

In game shows it is also known as a "lockout system," because when one person signals ("buzzes in"), all others are locked out from signalling. Several game shows have large buzzer buttons which are identified as "plungers".



#### ZIGBEE

ZigBee is a specification for a suite of high level communication protocols used to create personal area networks built from small,

low-power digital radios. ZigBee is based on an IEEE 802.15 standard. Though low-powered, ZigBee devices often transmit data

over longer distances by passing data through intermediate devices to reach more distant ones, creating a mesh network; i.e.,

a network with no centralized control or high-power transmitter/receiver able to reach all of the networked devices. The decentralized

nature of such wireless ad hoc networks make them suitable for applications where a central node can't be relied upon.

# **RAIN SENSOR MODULE**

The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board

and also for measuring rainfall intensity. The module features, a rain board and the control board that is separate for more convenience,

power indicator LED and an adjustable sensitivity though a potentiometer.

The analog output is used in detection of drops in the amount of rainfall. Connected to 5V power supply, the LED will turn on when induction board has no rain drop, and DO output is high. When dropping a little amount water, DO output is low, the switch indicator will turn on. Brush off the water droplets, and when restored to the initial state, outputs high level.

# GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a satellite based navigation system that can be used to locate positions anywhere on earth. Designed and operated by the U.S. Department of Defense, it consists of satellites, control and monitor stations, and receivers. GPS receivers take information transmitted from the satellites and uses triangulation to calculate a user's exact location.





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### DHT11 – TEMPERATURE AND HUMIDITY SENSOR

The DHT11 sensor can either be purchased as a sensor or as a module. Either way, the performance of the sensor is same. The sensor will come as a 4-pin package out of which only three pins will be used whereas the module will come with three pins as shown above.

The only difference between the sensor and module is that the module will have a filtering capacitor and pull-up resistor inbuilt, and for the sensor, you have to use them externally if required.

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of  $\pm$ 1°C and  $\pm$ 1%. So if you are looking to measure in this range then this sensor might be the right choice for you.

The DHT11 Sensor is factory calibrated and outputs serial data and hence it is highly easy to set it up. The connection diagram for this sensor is shown below.



## **III. CONCLUSION**

This study has successfully demonstrated the application of IoT-based monitoring systems for tracking wildlife health and migration patterns. The comprehensive deployment of GPS, health, and environmental sensors provided continuous, real-time data that significantly enhanced our understanding of wildlife behaviors and habitat interactions. Key findings revealed distinct migration routes used by various species, critical habitats that require protection, and correlations between environmental conditions and wildlife health metrics. The continuous monitoring of vital signs such as heart rate and body temperature allowed for early detection of stress and potential health issues, providing invaluable data for timely conservation interventions. The integration of various sensors facilitated a multidimensional analysis that traditional methods could not achieve. By combining location data with health and environmental metrics, the study offered a holistic view of the factors influencing wildlife behavior and health. The IoT system's ability to operate autonomously and transmit data remotely minimized human interference and reduced the risks associated with invasive monitoring techniques. These findings underscore the system's effectiveness in providing detailed, accurate, and actionable insights, contributing significantly to wildlife conservation strategies. In conclusion, this study has demonstrated the transformative potential of IoT technology in wildlife conservation. The key findings underscore the value of continuous, realtime monitoring for understanding wildlife behavior and health. While significant progress has been made, ongoing research and innovation are essential to further enhance the capabilities and applications of IoT systems. By addressing current limitations and exploring new research directions,IoT technology can play a crucial role in ensuring the long- term preservation of wildlife and the health of ecosystems worldwide.

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